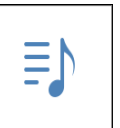




Armed Forces College of Medicine AFCM





Small Intestine Motility

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Anan**

Ass. Prof. Physiology



Intended learning objectives (ILOs)



- ❖ Describe the different types of the small intestine motility
- ❖ Compare segmentation contractions and peristaltic contraction
- ❖ Interpret the significance and functions of GIT hormones in GIT motility and functions
- ❖ Apply knowledge to solve clinical problem



Motility of the small intestine (SI)

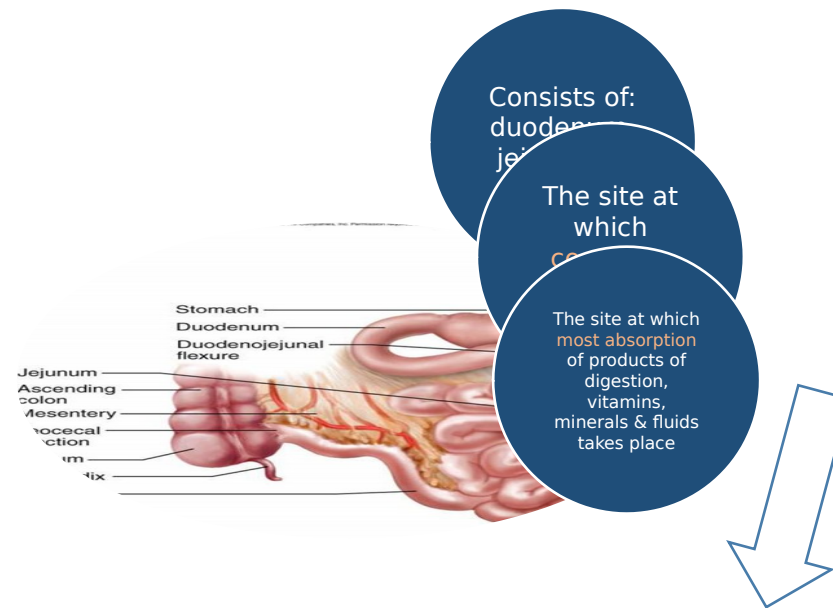


Introduction

- Small intestinal motility is characterized by brief, irregular contractions interrupted during fasting approximately every 60-90 min by a wave of intense contractions, migrating motor complexes, (MMCs) that sweeps the entire length of the small intestine.



Motility of the small intestine (SI)



Motility of the small intestine (SI)



- ❖ The contractile patterns of the small intestinal muscular layers are primarily determined by integrated neural circuits within the gut wall “the enteric nervous system”
- ❖ The CNS and gut hormones also have a modulatory role on motility
- ❖ The interstitial cells of Cajal lie within the smooth muscle
- ❖ These mesenchymal cells appear to govern rhythmic contractions
- ❖ During fasting, a distally migrating sequence of motor events termed the migrating motor complexes (MMC) occurs in a cyclical fashion



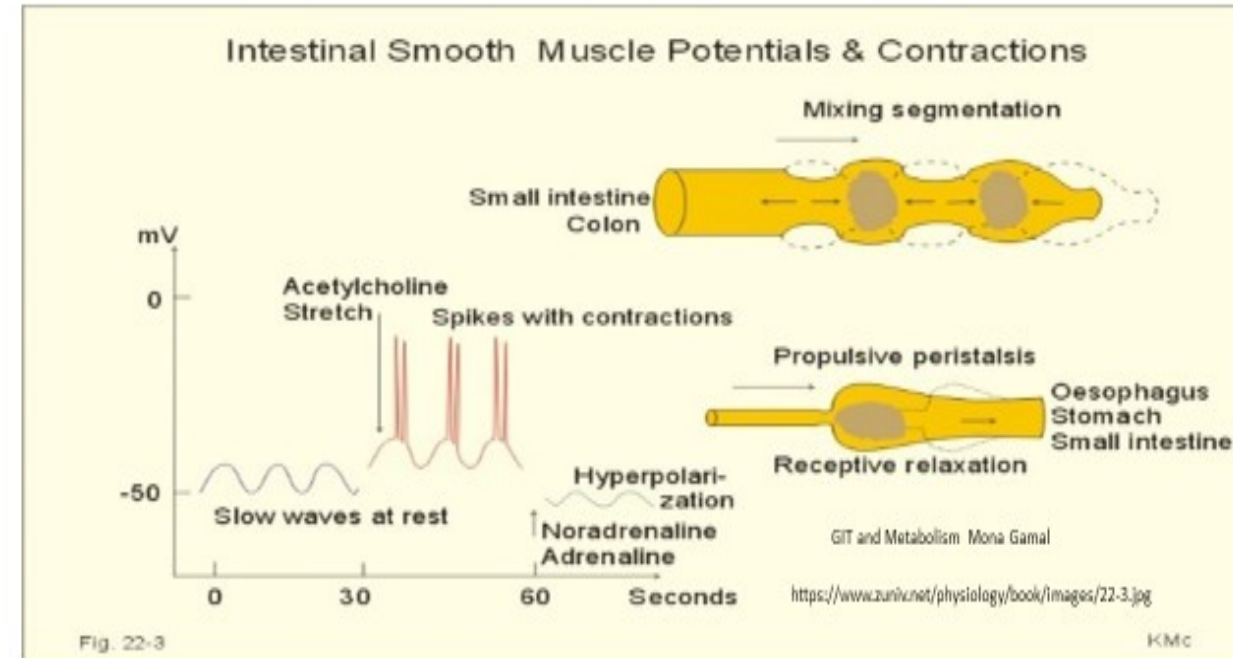
Motility of the small intestine (SI)



Motility

- Occur automatically via endogenous pacemaker activity
- Slow waves – contractions driven by graded depolarization
 - Produced by interstitial cells not by smooth muscle

Motility of the small intestine (SI)



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<https://www.zuniv.net/physiology/book/images/22-3.jpg>



Motility of the small intestine (SI)

Interstitial cells of Cajal



- Interstitial cells of Cajal (ICC) are the pacemaker cells in the gut. They generate and propagate slow waves in gastrointestinal muscles.
- The frequency of slow waves determines the frequency of contractions of the stomach, intestine, and colon.
- Slow waves also determine the direction and velocity of propagation of peristaltic activity, in concert with the enteric nervous system.

- Slow waves initiated by Interstitial Cells of Cajal
- Always present, but requires spike potentials to initiate contractions
- Frequency is 3/min stomach, 12/min duodenum, 7/min ileum, 9/min cecum, and 16/min sigmoid colon
- Whether spike potentials and, hence, contractions occur depends on neural, hormonal, and local influences



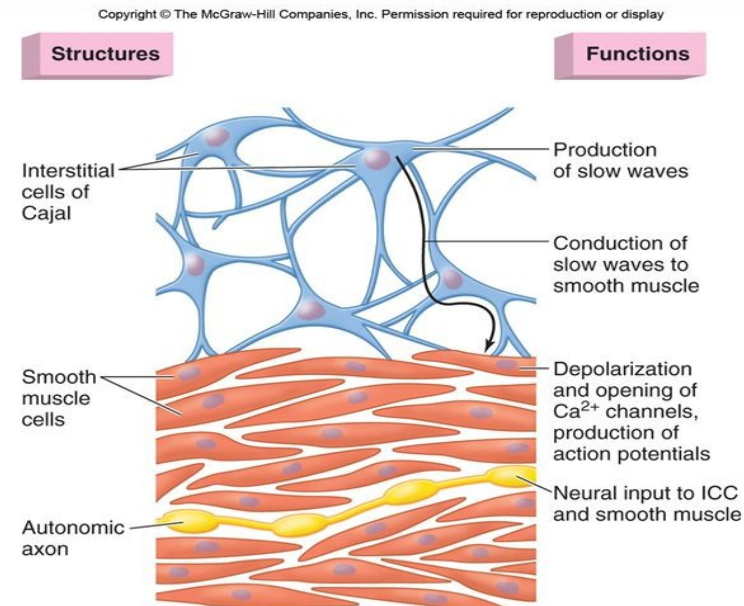
Motility of the small intestine (SI)



Slow Waves

- Produced by non-neuronal/non-muscular cells
 - interstitial cells of Cajal (ICC)
- Have long processes joined to each other
 - And to smooth muscle via gap junctions
 - Spreads depolarization from one

Regulation of Contraction



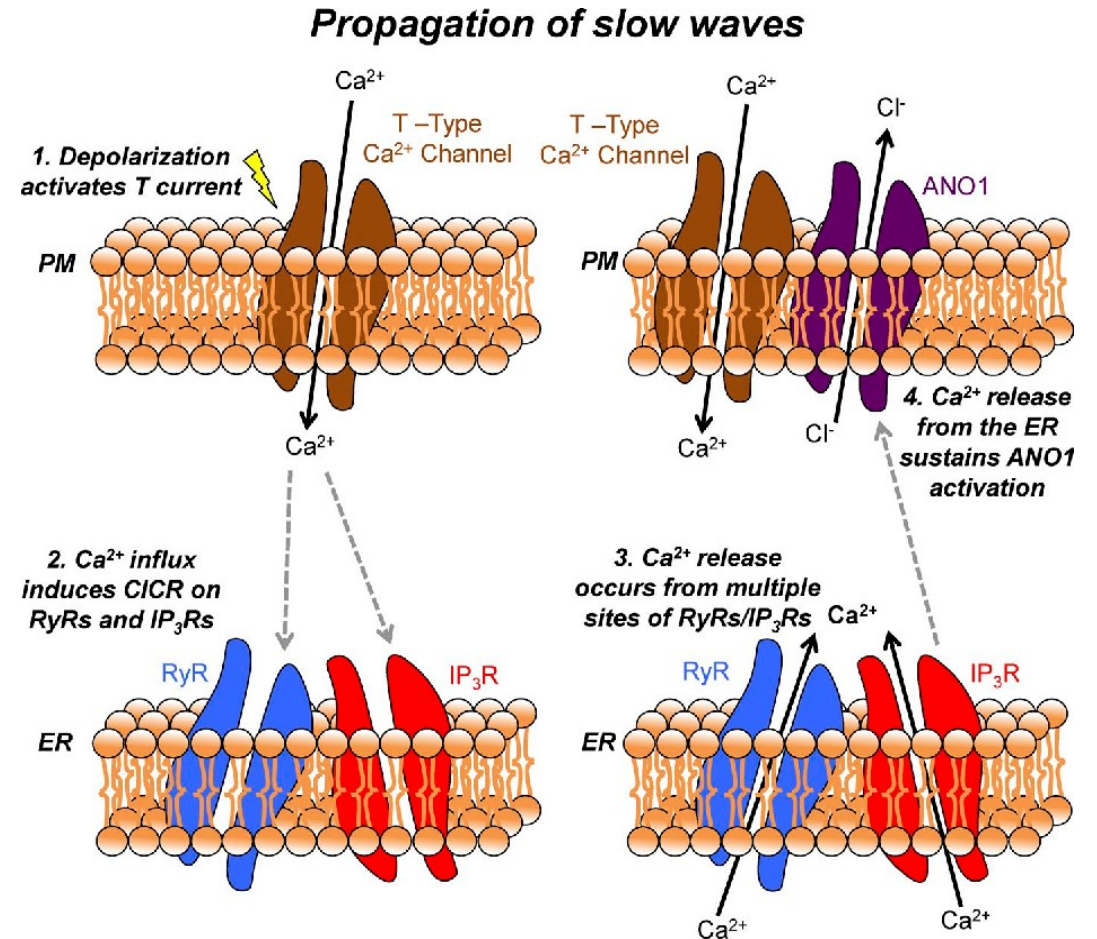
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Motility of the small intestine (SI) Slow Waves



- When slow waves exceed threshold – trigger APs in smooth muscle by opening VG Ca^{2+} channels
- Influx of Ca^{2+} produces depolarization phase of AP and stimulates contraction
- Repolarization occurs via K^{+} efflux
- Contractions are modified by ANS activity
 - ACh from parasympathetic division increases amplitude and duration of slow waves



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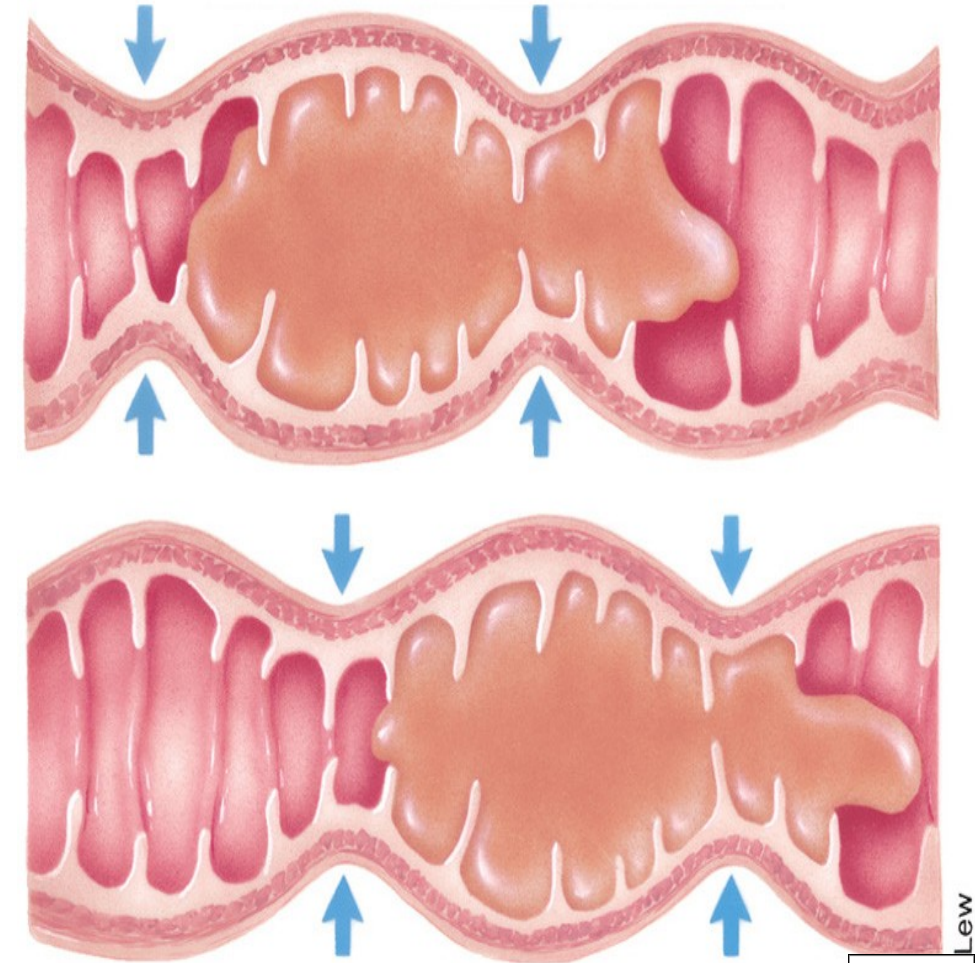


Motility of the small intestine (SI)

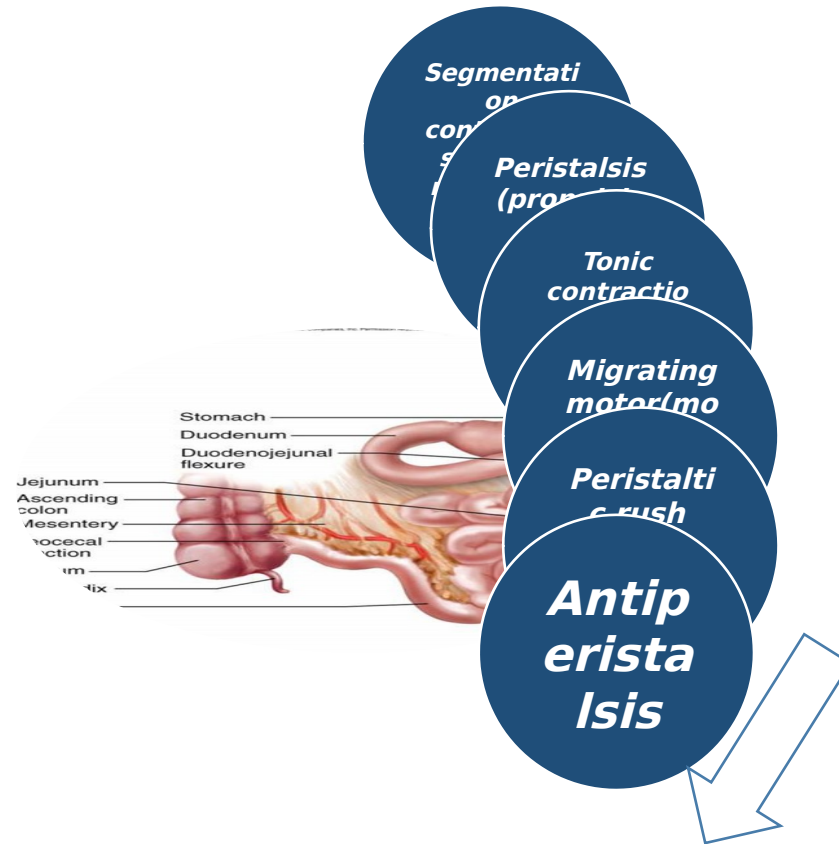
Intestinal Contractions and Motility



- 2 major types of contractions occur in small intestine:
 - Peristalsis: weak and slow, occurs mostly because pressure at pyloric end is greater than at distal end
 - Segmentation: major contractile activity of small intestine
 - Contraction of circular smooth muscle mixes chyme



Motility of the small intestine (SI)



Motility of the small intestine (SI)

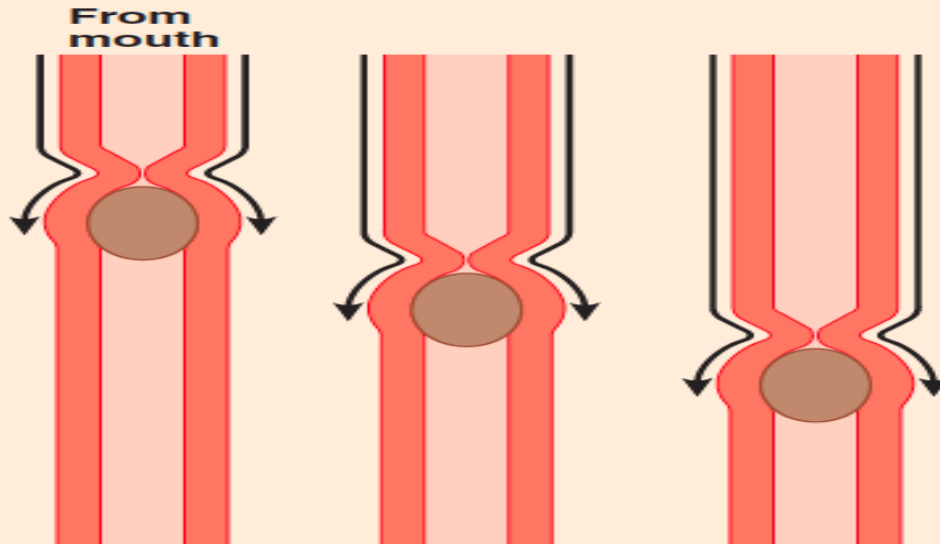


segmentation

(a) Peristalsis

Adjacent segments of the alimentary canal organs alternately contract and relax.

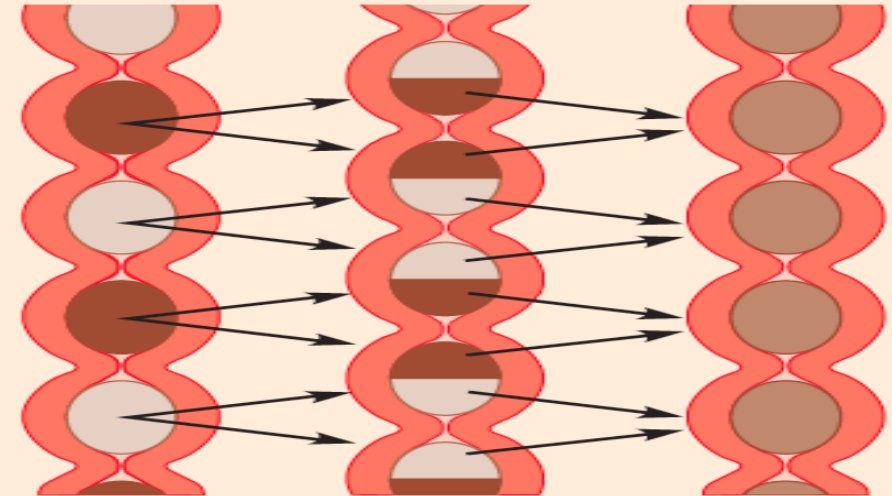
- Food is moved distally along the tract
- Primarily propulsive; some mixing may occur



(b) Segmentation

Nonadjacent segments of the alimentary canal organs contract and relax.

- Food is moved forward, then backward
- Primarily mixes food and breaks it down mechanically; some propulsion may occur



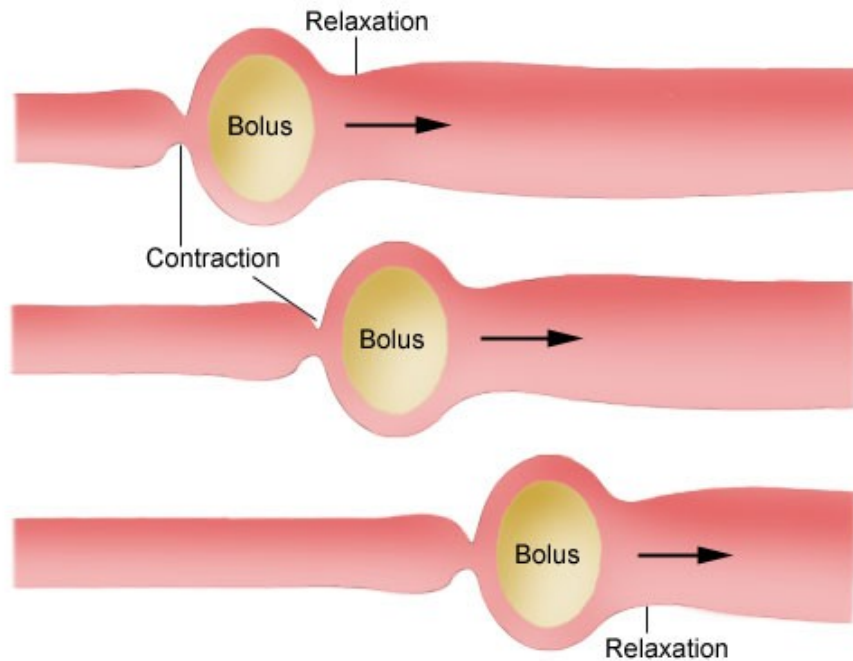
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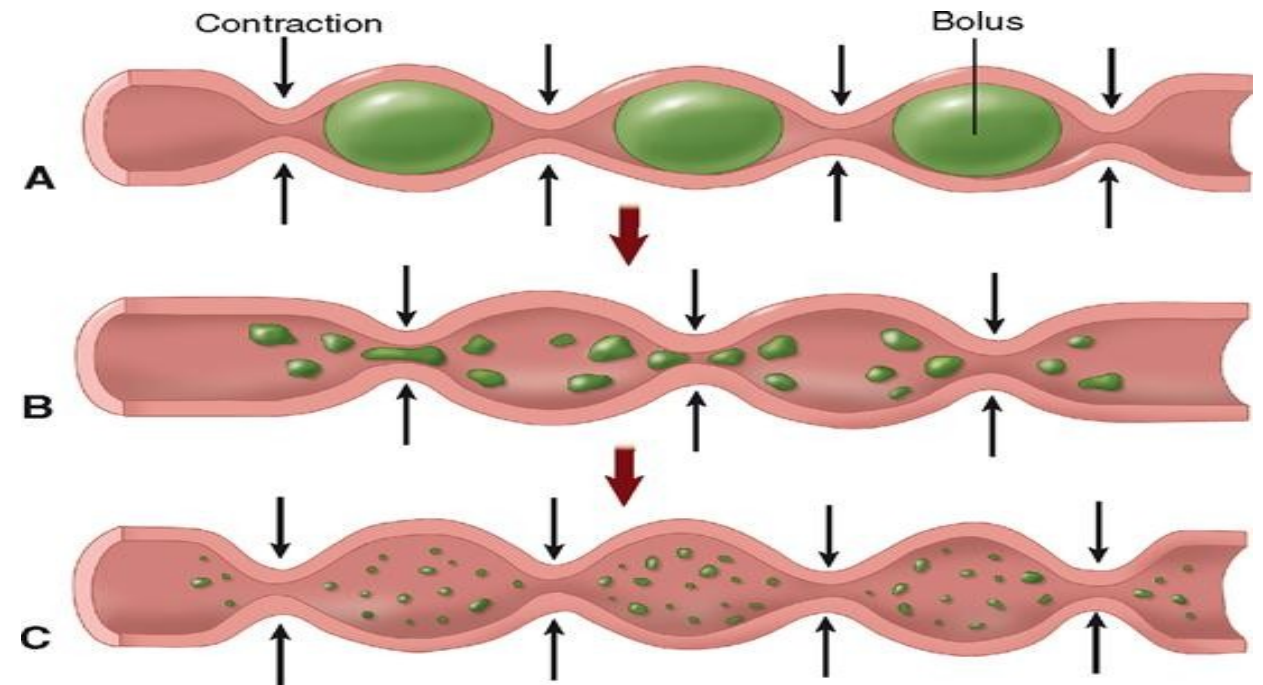
Motility of the small intestine (SI)



Peristalsis (propulsive movements)



Segmentation



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<https://basicmedicalkey.com/wp-content/uploads/2016/05/F500426f29-05-9780323096003.j>



Motility of the small intestine (SI)



Segmentation contractions (Mixing movements)

Peristalsis

(propulsive movements)

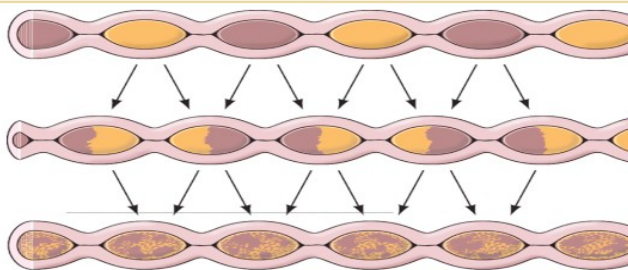
Timing & Nature

- ❖ Starts after meals “as ring contractions of circular muscles at several sites” □
- ❖ Dividing a portion of small intestine into segments (2-3 cm long)
- ❖ A few seconds later, contractions appear in the middle of each segment while previous constrictions disappear

- Starts after meals “in duodenum & proceed to other parts of small intestine”
- There is a ring constriction proximal to area of stretch & relaxation of muscles distal to area of stretch □ a peristaltic wave that proceeds from

Motility of the small intestine (SI)

Segmentation contractions (Mixing movements)
Move the chyme to & fro



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https://www.muhadharaty.com/files/lectures/017/lec17657.docx_4/image1.jpg

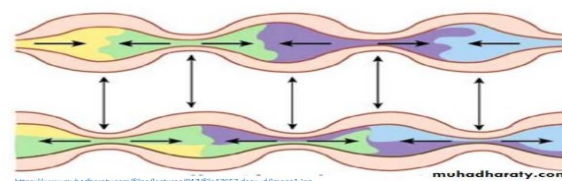
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Motility of the small intestine (SI)

Segmentation contractions (Mixing movements)
Move the chyme to & fro



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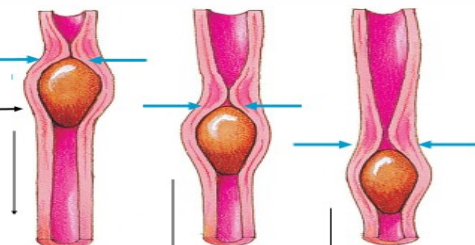
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Motility of the small intestine (SI)

Peristalsis

Circular muscles behind Bolus contract (ACh)

Muscles in front of Bolus relax (VIP)



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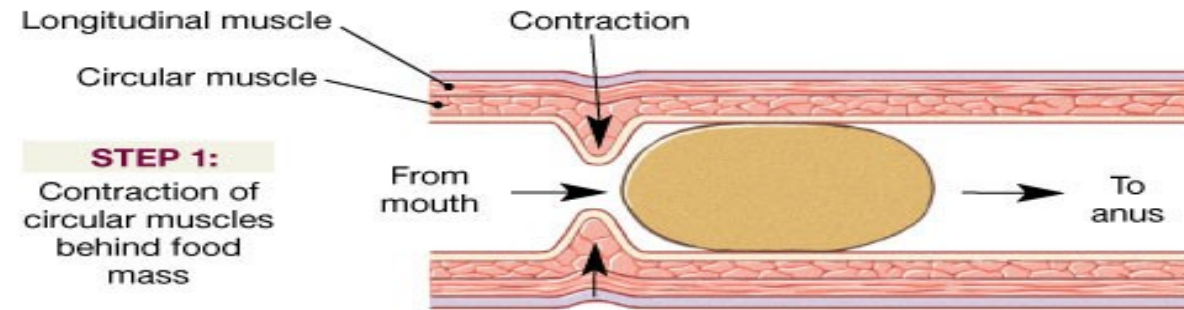
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Motility of the small Intestine (SI)



Peristalsis





Peristalsis



Segmentation and migrating motility complexes & Gastroileal reflex



	Segmentation contractions (Mixing movements)	Peristalsis (propulsive movements)
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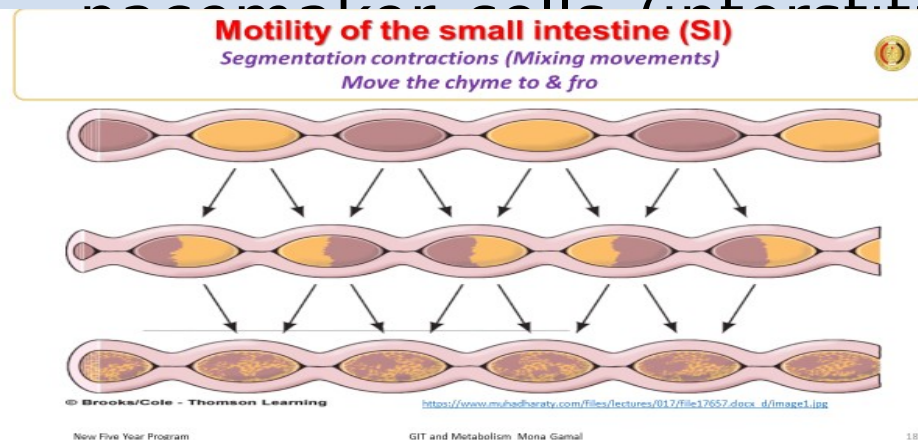
Timing & Nature

❖ The cycle is repeated at a rate of 12/min in duodenum & jejunum and 8/min in lower ileum “according to the basic electric rhythm of the small intestine (interstitial cells of Cajal)”

❑ They are weak → the movement of chyme is slow (1 cm/min) → Chyme passes from pylorus to ileocecal valve in 3-5 hours ≈ Traveling at a speed of 0.5-5 cm/sec. “Journey from pylorus to ileocecal valve”

❑ It dies off after few seconds

❑ Peristalsis are initiated by



Motility of the small intestine (SI)



Segmentation contractions (Mixing movements)

Peristalsis (propulsive movements)

Nature

Myogenic

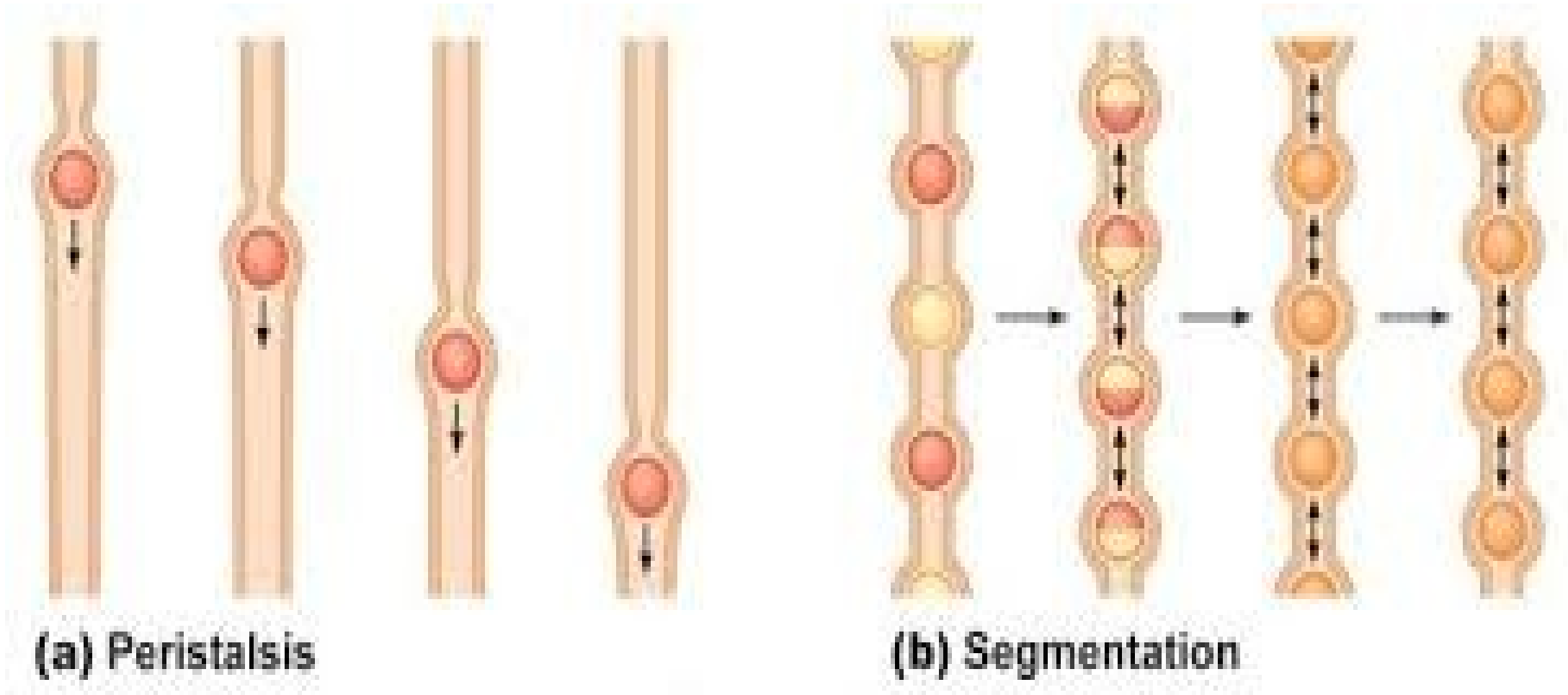
- ❖ Do not depend on nerve stimulation *but* it needs an intact enteric nervous system
- ❖ So, they *persist* after *cutting* the extrinsic nerves
- ❖ Become *weak* after *damage* or *blocking* of

Neurogenic

- ❑ Depend on enteric nervous system
- ❑ They *disappear* after *damage or blocking* of enteric nervous system



Motility of the small intestine (SI)



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[https://
www.google.com/url?sa=i&url=https%3A%2F%2Fquizlet.com%2F24469028%2Fphysio-ii-propulsion-mixing-of-food-p
art-ii-flash-](https://www.google.com/url?sa=i&url=https%3A%2F%2Fquizlet.com%2F24469028%2Fphysio-ii-propulsion-mixing-of-food-part-ii-flash-)



Motility of the small intestine (SI)

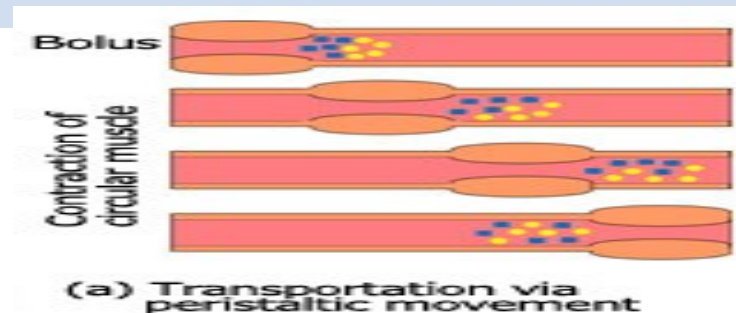
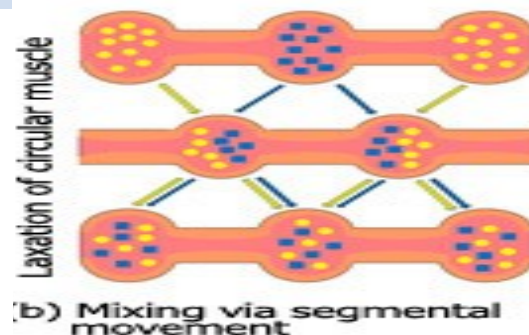
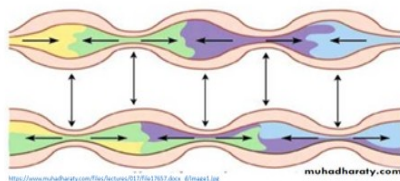


	<i>Segmentation contractions (Mixing movements)</i>	<i>Peristalsis (propulsive movements)</i>
Function	❖ 1- Move the chyme to & fro which allows: ✓ a- Mixing the chyme with digestive juices □ helps digestion ✓ b- Exposure of chyme to mucosal surface □ helps absorption ❖ 2- Help food propulsion “little effect” ❖ 3- Squeezing the lymph and the blood vessels	□ 1-Propulsive action: Propulsion of chyme along small intestine □ 2-Mixing of chyme with the digestive juice □ 3-Facilitation of absorption

Motility of the small intestine (SI)

Segmentation contractions (Mixing movements)

Move the chyme to & fro



Compare between Segmentation contractions and peristalsis

Motility of the small intestine (SI)



In sphincters
□ Separation
• Tonic Contraction

Elapsed Time	Segmentation	Tonic Contraction	Peristalsis
Function	Mixing	Separation (Sphincter)	Propulsion

https://www.google.com/url?sa=i&url=https%3A%2F%2Flink.springer.com%2Fchapter%2F10.1007%2F978-94-017-8771-0_2&psig=



Motility of the small intestine (SI)



The peristaltic rush

Neurogenic; vagal and local axon reflex

1-

It is a strong peristaltic wave traveling rapidly for a long distance of small intestine

2-

It occurs in response to strong irritation of intestinal mucosa by infection

3-

It also occur in intestinal obstruction

4-

It causes diarrhea

5-

Functions

Rapid proper emptying of the intestinal lumen



Motility of the small intestine (SI)

The antiperistalsis movement



Neurogenic; local axon reflex

Occurs in

1-Duodenum

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2-Ileum

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May occur during vomiting
to propel duodenal contents
into the stomach



Motility of the small intestine (SI)

Movement of the villi



Movement of the villi

1-

It is a hormonal
dependent
movement;
villikinin

2-

It consists of
shortening and
elongation of the
villi

3-

It facilitates
the absorption

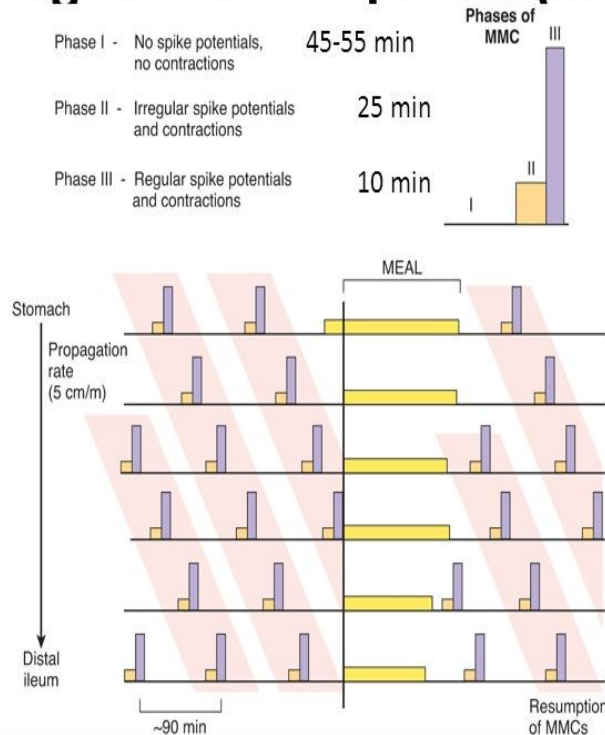


Motility of the small intestine (SI)

Migrating motor complexes



Migrating motor complexes (MMCs).



Migrating motor complexes (MMCs). Note that the complexes move down the gastrointestinal tract at a regular rate during fasting, that they are completely inhibited by a meal, and that they resume 90-120 minutes after the meal

MMC is motor activity in smooth muscle of GIT, migrating to distal ileum and increases during fasting

Each MMC cycle consists of 3 phases:

- period of motor quiescence (**phase I**)
- period of irregular contractile activity (**phase II**)
- a short (5-10 min) burst of regular phasic contractions (**phase III**)

Each MMC cycle lasts for approximately 90 -120 minutes and is ***completely inhibited by meals***

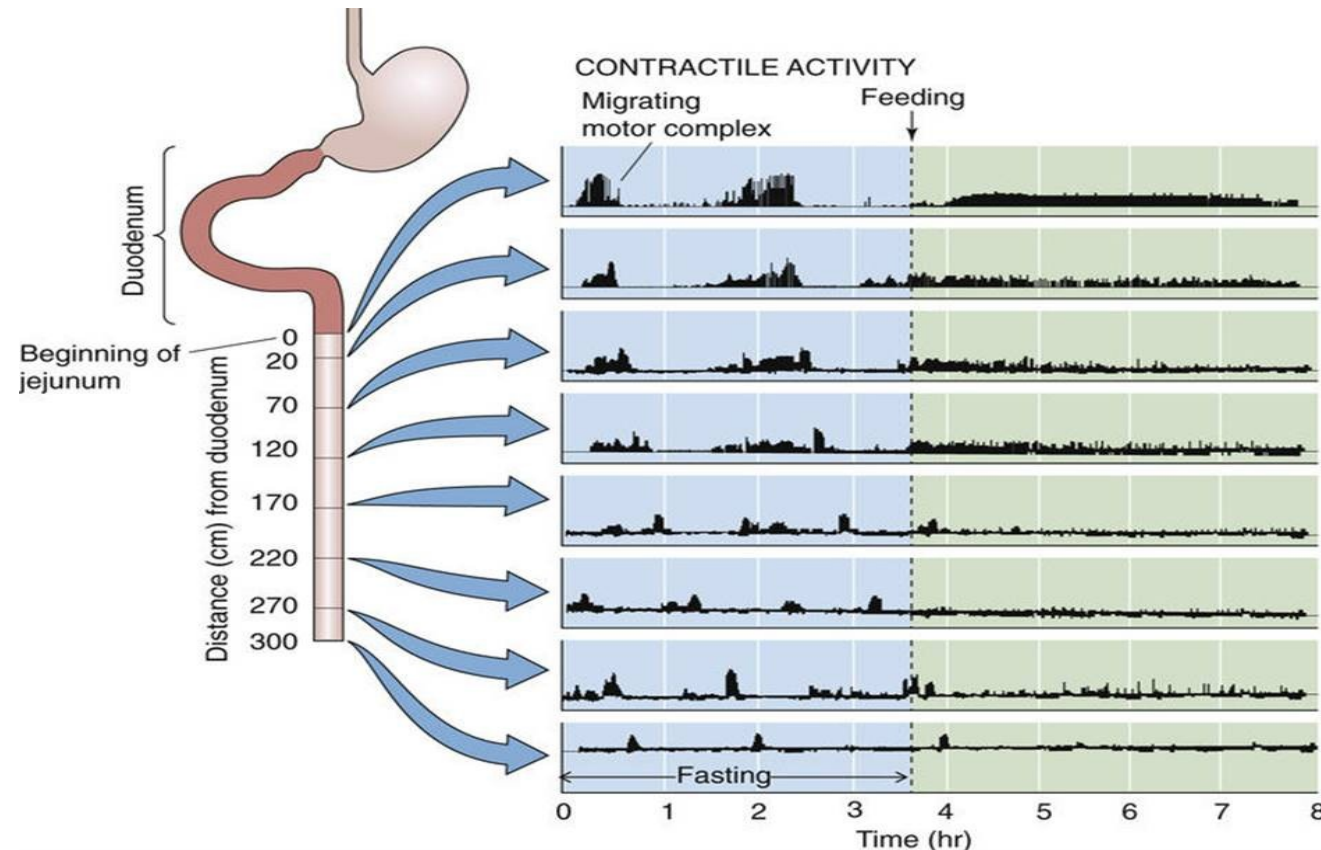
After a meal, the MMC pattern is disrupted and replaced by irregular contractions. This seemingly chaotic-fed pattern lasts typically for 2-5 hours, depending on the size and nutrient content of the meal

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Motility of the small intestine (SI)

Migrating motor complexes



Physiological significance

(housekeeping) □

1. Allows for movement of large particles such as pills, capsules, or buttons through the bowel;
2. Sweeps indigestible or residual luminal material in the small Intestine into the large Intestine;
3. Prevents bacterial buildup in

<https://doctorlib.info/physiology/medical/medical.files/image1839.jpg>



Control of intestinal motility



Control of intestinal motility

1) Nervous control

a- Intrinsic nerve plexuses
“Essential for peristalsis & accentuate segmentation”

After meals
myenteric R.
↑
peristalsis

gastroenteric R.
i.e.
↑
motility

b- Extrinsic Ns.

Vagal
(+) □
↑
motility

Sympathetic □
↓
motility

2) Hormonal control

CCK, Gastrin,
Motilin,
Insulin,
Serotonin &
Sub.P □
↑
motility

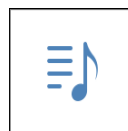
Secretin &
Glucagon □
↓
motility





and functions

	Production	For Production	Target organ	Function
Cholecystokin in (CCK)	Duodenal mucosa	Fatty Chyme	Stomach Liver/pancreas Pancreas Gallbladder Hepatopancreatic sphincter	Inhibits stomach's secretory activity Potentiates secretin's actions Increase pancreatic secretion Stimulate contraction and expulsion of bile Relaxes sphincter allowing secretions into duodenum
Secretin	Duodenal mucosa	Acidic chyme	Stomach Pancreas Liver	Inhibits gastric gland secretion Inhibits gastric motility during gastric secretion Increases pancreatic juice secretion & potentiates CCK Increases bile output
Motilin	Duodenal mucosa	Fasting; periodic release by neural stimuli (1.5-2 hrs)	Proximal duodenum	Stimulates MMC
Vasoactive intestinal peptide (VIP)	Enteric neurons	Partially digested food	Small intestine Pancreas Stomach	Stimulates buffer secretion Dilates intestinal vasculature Relaxes intestinal smooth muscle Increases secretion Inhibits acid secretion



Hormones affecting GIT motility



Hormone	Site of Production	Stimulus For Production	Target Organ	Activity
Gastric inhibitory peptide (GIP)	Duodenal mucosa	Fatty chyme	Stomach Pancreas (beta cells)	Inhibits HCl production Stimulates insulin release
Gastrin	Stomach mucosa - G cells	digested food; acetylcholine released from nerve cells	Stomach (parietal cells) Small intestine Ileocecal valve Large intestine (LI)	Partially Increases HCl secretion Stimulates gastric emptying Stimulates small intestine contractions Relaxes ileocecal valve Stimulates movement of LI
Intestinal gastrin	Duodenal mucosa	Acidic and partially digested food in duodenum	Stomach	Stimulates gastric glands and motility





Ileocecal junction

It is the last few centimeters of the ileum, with a thick muscular coat

It prevents the regurgitation of the colonic contents into the ileum

Ileocecal valve

Ileocecal sphincter

Valve - like mucous Folds

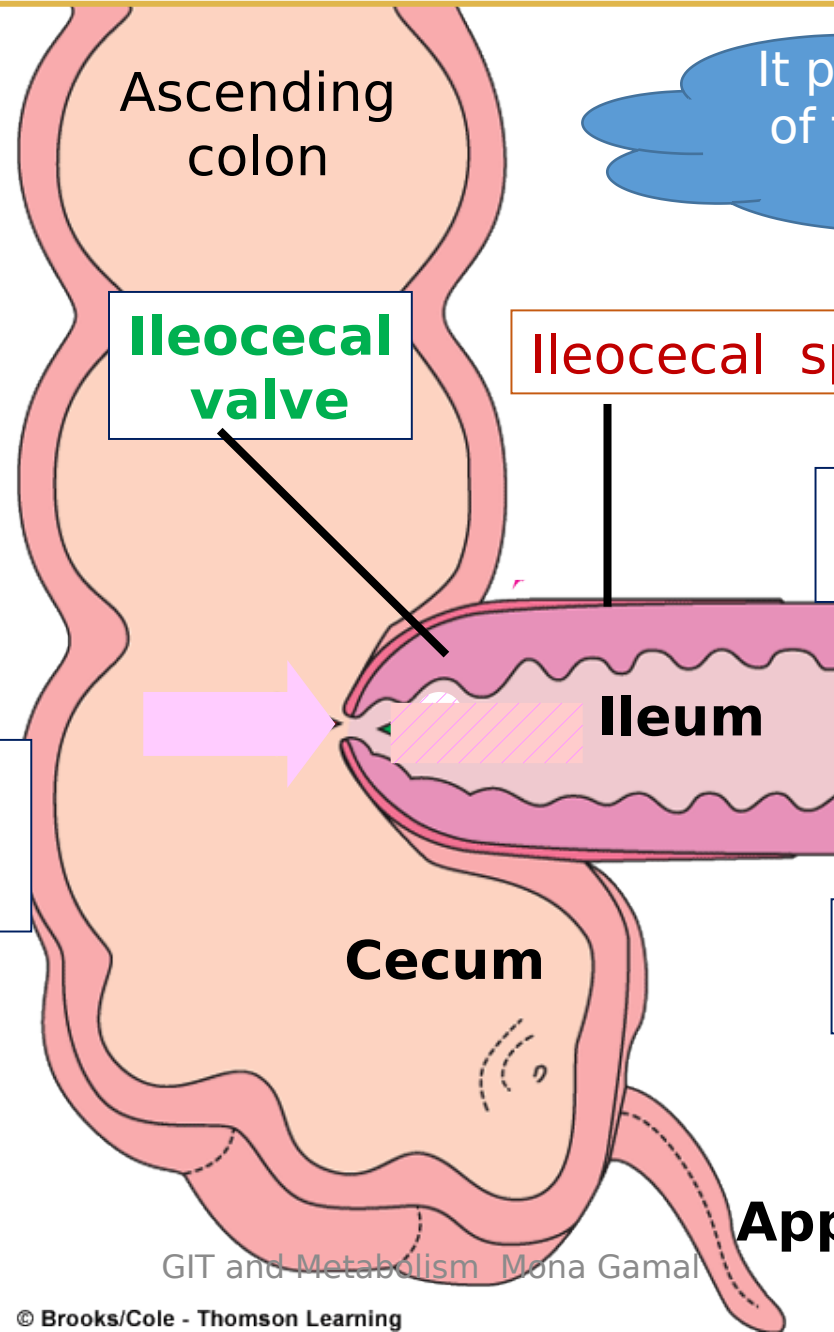
Thickened

Folds of tissue protrude from ileum into cecum

Mildly contracted most of the time

It is normally closed

Under neural & hormonal control

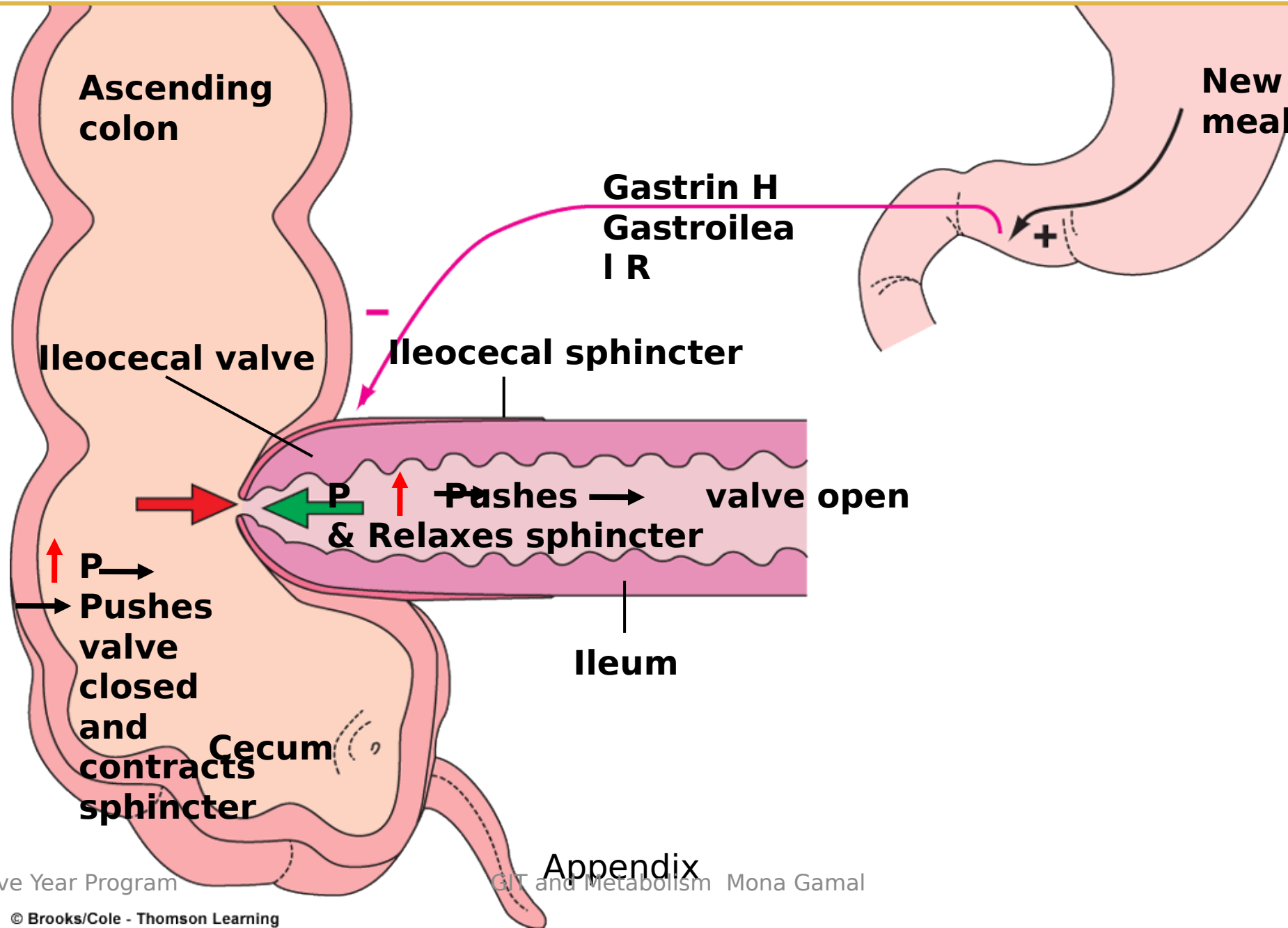


Appendix

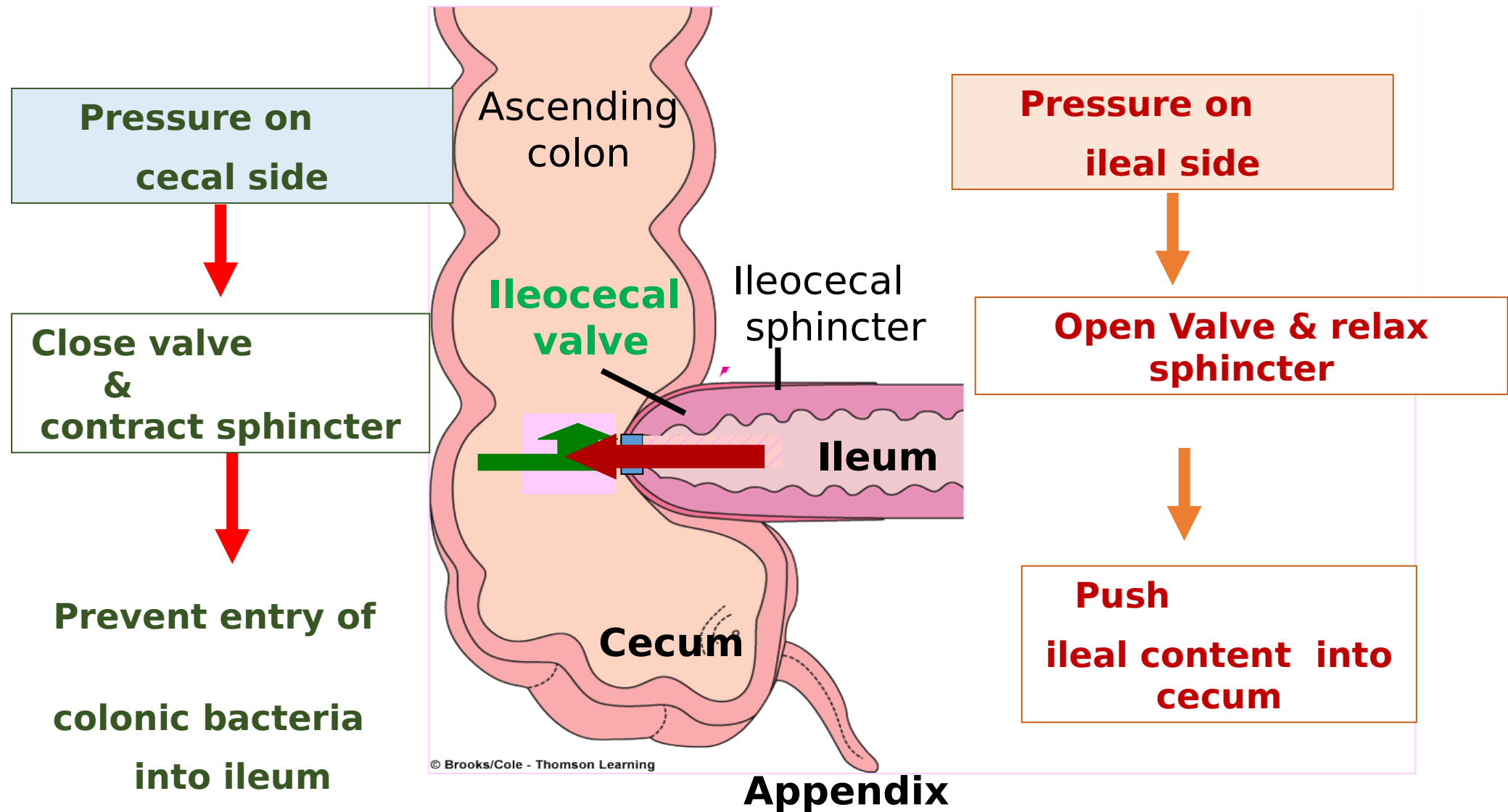


Enumerate the different function of Cholecystokinin hormone

Control of ileocecal sphincter



Control of ileocecal valve and sphincter



Intestinal reflexes



- **Peristaltic reflex**
or “law of the intestines”, i.e., upstream contraction and downstream receptive relaxation when a bolus distends the intestine

- **Intestinointestinal reflex**
is an inhibition of contractile activity when the intestine is severely distended

- **Gastroileal reflex**
is a relaxation of the ileocecal sphincter after a meal □ **allows** chyme to pass from small intestine into large intestine
This reflex is **mediated** by vagus nerve and gastrin

- **Gastrocolic reflex**
is stimulation of high or low amplitude colonic contractility with gastric distention or nutritive stimulus

Ileocolic Reflex

On coecal irritation there will be reflex inhibition of the ileal peristalsis and constriction of ileocecal sphincter



Adynamic “Paralytic” ileus; Non-mechanical or functional intestinal obstruction



Paralytic” ileus

1. It is a state of a decreased intestinal motility due to inhibition of the smooth muscle layer

2. It is due to overstimulation of the adrenergic receptors β_2 in the longitudinal muscle layer and α_1 in the sphincters

3. This commonly occurs with
a. peritoneal irritation or
b. excess sympathetic stimulation e.g. due to excess handling of the intestine

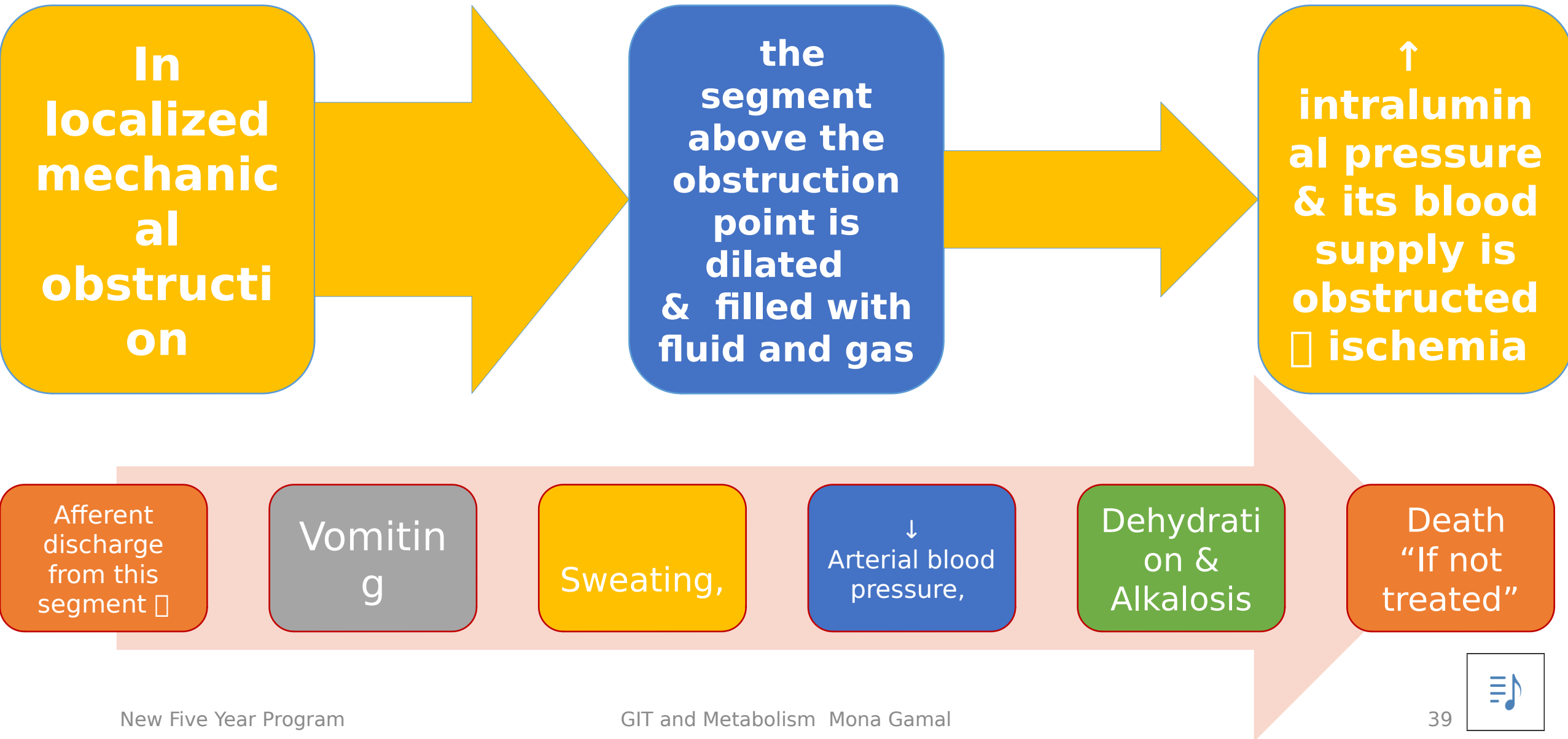
3. Peristalsis is lost, intestinal contents are not propelled into the colon leading to over distension with loss of motility

4. Fluid and gas pockets appear in the intestine
The condition is usually painless

5. Ryle tubing is the best solution
□ diminution of distension □ return of intestinal peristalsis
“in 6-8 hours.....”

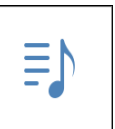


Mechanical intestinal obstruction





- Different types of small intestine motility takes place at different timing
- The nature and functions of each movement differs from the other
- Control of small intestine motility may be neural or hormonal
- Different reflexes take place in GIT “may be inhibitory or excitatory
- Many hormones affecting GIT motility and functions
- Disturbance of the normal pattern of small intestine motility may lead to diseases or even death





Migrating motility complexes (MMC) occur about every 90 min between meals and are thought to be stimulated by the gastrointestinal hormone, motilin. An absence of MMCs causes an increase in which of the following?

- A) Duodenal motility
- B) Gastric emptying
- C) Intestinal bacteria
- D) Mass movements
- E) Swallowing

SUGGESTED TEXTBOOKS



1. Ganong's "Review of Medical Physiology", 25th edition,
Section V gastrointestinal physiology, Chapter 26
2. Guyton and Hall "Textbook of Medical Physiology", 13th
edition, Chapter 64, Secretory Functions of the Alimentary
Tract, from page
3. Sembulingam "Essentials of Medical Physiology", 6th
edition, Chapter 41

